**GOVERNING BOARD**

<table>
<thead>
<tr>
<th>Honorable W. S. Dolan</th>
<th>Milbank</th>
</tr>
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<tr>
<td>Honorable Guy H. Harvey</td>
<td>Yankton</td>
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<tr>
<td>Honorable Alvin Waggoner</td>
<td>Philip</td>
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<tr>
<td>Honorable J. E. Peart</td>
<td>Flandreau</td>
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<tr>
<td>Honorable Will A. Wells</td>
<td>Webster</td>
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</tbody>
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**STATION STAFF**

<table>
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<tr>
<th>Executive</th>
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<tbody>
<tr>
<td>W. S. Dolan</td>
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<td>J. E. Peart</td>
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<tr>
<td>Chas. W. Pugsley, B.S., D.Agr.</td>
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<tr>
<td>C. Larsen, B.Sc.Agr. M.S.</td>
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<tr>
<td>James W. Wilson, B.S.A., M.S.A., LL.D.</td>
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<tr>
<td>N. E. Hanson, B.S., M.S., Sc.D.</td>
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<tr>
<td>A. N. Hume, B.S.A., M.S., Ph.D.</td>
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<tr>
<td>R. A. Larson</td>
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<td>A. A. Applegate, A.B., M.A.</td>
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<td>June Disbrow</td>
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**Agricultural Engineering**

| Ralph Patty, B.Di., B.S. in A.E. | Agricultural Engineer |
| H. M. Crothers, B.S., E.E., Ph.D. | Associate |
| D. E. Wiand, B.S., in A.E. | Assistant |

**Agronomy**

| A. N. Hume, B.S.A., M.S., Ph.D. | Agronomist |
| J. G. Hutton, B.S., M.S. | Associate |
| K. H. Klages, B.S., M.S., Ph.D. | Associate |
| M. Fowlds, B.S. | Assistant |
| Leo Puhr, B.S., M.S. | Assistant |
| C. Franzke, B.S. | Assistant |

**Animal Husbandry**

| James W. Wilson, B.S.A., M.S.A., LL.D. | Animal Husbandman |
| Turner Wright, B.S. | Associate |
| Forrest Penn, B.S., M.S. | Assistant |

**Chemistry**

| K. W. Franke, B.S., M.S., Ph.D. | Chemist |
| Florence Marx, B.S. | Analyst |

**Dairy Husbandry**

| T. M. Olson, B.S., M.S.A. | Dairy Husbandman |
| Dan Jacobsen, B.S., M.S. | Assistant |

**Home Economics**

| Edith Pierson, B.S., M.S. | Home Economist |
| Anna Halgrim, B.S., M.A. | Associate |
| Minerva Kellogg, B.S., M.S. | Assistant |

**Entomology**

| H. C. Severin, B.A., M.A. | Entomologist |
| George Gilbertson, B.S., M.S. | Assistant |

**Agricultural Economics**

| Sherman Johnson, B.S., M.S. | Agricultural Economist |
| R. E. Post, B.S., M.S. | Associate |
| Frank Hady, B.A. | Assistant |
| C. M. Hampson, B.S., M.S. | Assistant |
| G. Lundy, B.S., M.S. | Assistant |
| Poul Christopherson | Statistician |

**Horticulture**

| N. E. Hansen, B.S., M.S., Sc.D. | Horticultrist |
| F. J. LeBlanc, Ph.C., B.S., M.S. | Pharmacist |

**Pharmacy**

| W. C. Tully, B.S.A., M.S.A. | Poultry Husbandman |

**Poultry**

| W. F. Kurnien, B.S., M.S., M.S. | Rural Sociologist |
| Paul H. Landis, A.B., M.A. Ph. D. | Assistant |

**Veterinary**

| C. C. Lipp, D.V.M. | Veterinarian |
| J. B. Taylor, D.V.M. | Assistant |
ANNUAL REPORT

Mr. C. Larsen
Dean of Agriculture
College

Dear Sir:

I have the honor to submit the following report of the South Dakota Agricultural Experiment Station, as required by law, for the fiscal year ending June 30, 1933.

There was one change in the personnel of the staff during the year. Miss Minerva Kellogg was employed to succeed Miss Grace Wasson, of the Home Economics Department, who resigned.

Publications

There were nine bulletins and eight circulars printed during the year as follows:

**Bulletin**

- No. 272 Crop Yields Over 19 Years at Highmore Forage Testing Station
- No. 273 The Effect of Milk Foam on Dairy Calves
- No. 274 South Dakota Town-Country Trade Relations
- No. 275 Germination of Seed Corn and Its Relation to Moulds
- No. 276 Winter Wheat Production in South Dakota
- No. 277 Rammed Earth Walls for Farm Buildings
- No. 278 Methods of Feeding and Grain Rations for Fattening Lambs
- No. 279 Growth and Decline of South Dakota Trade Centers
- No. 280 Results from 20 Years Complete Fertility Tests

**Circular**

- No. 6 Tractor and Horse Power in the Wheat Area of South Dakota
- No. 7 Farm Mortgage Experiences of Life Insurance Companies
- No. 8 Emergency Farm Adjustments in the Wheat Area of South Dakota
- No. 9 Some Aspects of Farm Mortgage Situation in South Dakota
- No. 10 Mortgage Loans on Real Estate in Clark County
- No. 11 Motor Truck Transportation in Western South Dakota
- No. 12 Mortgage Loans on Farm Real Estate in Turner County
- No. 1 Reprint on “Soil Survey”

The number of copies of these publications printed varied from five to fifteen thousand. There were 21,672 Station bulletins sent out to residents of South Dakota, 11,911 to parties in other states and 1,684 to foreign countries, making a total of 35,267 bulletins distributed during the year.

For a more detailed statement I attach hereto and make a part of this report the report of the chief of each division of the station.

Yours truly,

James W. Wilson
Director of Experiment Station
Agricultural Economics
By R. E. Post, Acting Head

The research work of the Department of Agricultural Economics is supported entirely by Purnell funds. The active projects of the department may be classified into the following lines of work: (1) Agricultural Finance, (2) Marketing, (3) Prices, (4) Land Economics, (5) Economics of Production.

Studies in Agricultural Finance
A Study of the Credit Needs of South Dakota Agriculture and the Agencies Serving It

The work on this project for the past year has been divided into two phases: (1) A continuation of the study of the farm real estate mortgage situation in selected counties of the state; (2) a study of the mortgage delinquency and farm foreclosure situation in the State and its bearing on a future land use policy.

The first phase of this study aims to assemble all relevant information in regard to amount of indebtedness, the acreage mortgaged, source of funds, terms of loans, rates of interest, ratio of debt to value, delinquencies, foreclosures, the effect of land purchase on indebtedness, etc., in so far as such information is available from county records. The problem is approached by studying historically the records of certain counties in order to determine the development of long term credit needs, how these needs have been met in the past, and what changes may be possible and desirable for the future.

The plan of work has been to collect farm real estate mortgage data from the office of the county register of deeds. The counties of Brookings, Clark, Haakon, Hyde and Turner were selected. In each county three representative townships were chosen from which to procure information covering all mortgage transactions and sales recorded since 1905 or earlier, in order to have complete data from the year 1910 on up to 1930 inclusive. The data have been classified, tabulated, analyzed and written up for the years 1910, 1915, 1920, 1925 and 1930, so as to show the conditions and changes by five year periods.

According to the plan a preliminary report has been made or is to be published for each of the five counties. Finally a combined publication covering the study in all the areas selected is to be issued. Consideration has also been given to the development of a plan to keep this farm mortgage information up-to-date.

Preliminary reports covering all the counties studied either have been published or are about ready for the printer. In July, 1930 the mimeographed circular No. 15, "Farm Land Mortgage Loans in Brookings County, South Dakota, for the years 1910 to 1927" was issued. Reports on two more counties have been printed, as follows: Circular 4, March, 1932, "Farm Real Estate Mortgage Loans in Hyde County, South Dakota, 1910-1930," and Circular 5, April, 1932, "Mortgage Loans on Farm Real Estate in Haakon County, South Dakota, 1910-1930." The manuscripts for the circulars on Clark and Turner counties are now ready for the printer. It is hoped to bring out a printed revision of the Brookings county study with additional data up to and including 1930, on a basis comparable with the
other county reports. (The additional data have already been procured.)
As yet no economical method has been found for keeping this farm mort-
gage information up-to-date.

Conclusions regarding this first phase of this study are as follows: It
appears that the chief difficulty of the farmers in the areas studied have
come from the economic disturbances created by the World War. The in-
flation in land values with heavy indebtedness resulted in acute financial
difficulties, delinquencies and foreclosures during the succeeding period of
depression. Purchasers of farm land, and borrowers as well as lenders
need to give more attention to the consequences of changes in the price
level, and guard against the unfavorable consequences of assuming heavy
obligations during periods of inflation. Land values need to be stabilized
for purposes both of purchase and borrowing.

The area of land under mortgage shows less fluctuation than the vol-
ume of indebtedness, indicating that farm indebtedness is a matter of long
duration. Hence, the prevailing five-year loan is inadequately brief, and
should be replaced by loans of longer term. Furthermore it appears that
the net annual farm income is (or must be) small in relation to the size of
the average farm loan. For this reason the method of repayment should
also be changed. The long term amortization loan would seem to fit the
needs of the farmer borrower better than does the loan payable in full at
maturity. However, it would be desirable to arrange for larger repayments
during good years in order to reduce delinquency and foreclosures in
times of reduced income. These changes would also seem to be within the
range of possibility, because the source of funds in the eastern part of the
state has shifted from individuals to specialized, corporate financial agen-
cies having at their disposal a rather permanent and constant source of
funds available for long term investment. With more stable and conserva-
tive land values and loans, and with a loan contract better fitted to meet
the needs of farmer borrowers, farm loans should become more safe and
attractive to investors and the cost of long-term farm loans should be re-
duced.

The second phase of this study aims to assemble all available informa-
tion regarding the development of the present farm mortgage delinquency
and foreclosure situation in order better to understand its significance
with regard to development of future land use policy. The concentration
of distressed land in the hands of various public and private agencies is
one of the problems studies in order to develop, if possible, means of avoid-
ing further concentration and sound methods of disposing of the land now
held as the result of foreclosure and tax delinquency.

Available information regarding the development of the present farm
mortgage situation was collected from various sources. Census data were
used as sources for county figures on mortgage debt, interest paid, ratio
of debt to value, etc. Information regarding the lending experience of the
various lending agencies was secured both from published reports and
from the business files of different agencies. The State Insurance Depart-
ment made available the annual reports of insurance companies for a
study of the lending experience of these agencies. Data regarding the
number and acreage of farm foreclosures were secured from the register
of deeds offices in the various counties. County records were also studied
to determine the extent of land concentration.

This second phase of the study has been considered as an emergency
analysis and a general report has been published as Circular No. 9, entitled
"Some Aspects of the Farm Mortgage Situation in South Dakota and Their Relation to a Future Land Use Policy." A special report on the lending experiences of life insurance companies was published as South Dakota Experiment Station Circular No. 7.

It was found that over 30,000 farm foreclosures had been instituted in South Dakota during the years 1921-31. These had involved an area of about 6,841,000 acres, equivalent to about 18 per cent of the assessed acreage of agricultural land in the state. Foreclosures in Brookings county were traced over a period of 52 years. It was found that in the years 1885-1896 there was a large number of farm foreclosures and apparently a situation closely paralleling the years 1921-32.

With respect to the concentration of distressed land in the hands of private and public agencies, it was found that the land in the hands of public agencies such as the Rural Credit Board constitutes a much larger area than the land acquired by private agencies. Since outside lending agencies such as insurance companies largely confined their lending operations to the eastern one-third of the state, it is probable that their proportional investment in distressed land is much higher than the area which they own would indicate. The public land which has been acquired is found mostly in the western two-thirds of the state.

The amount of distressed land held by public agencies raises the problem of handling the "new public domain" which does not consist of one solid block of land under the control of one agency, but rather of widely scattered tracts under the supervision and control of at least six different public agencies. In the handling and disposing of this land it would seem that policies should be developed which would not allow a repetition of past mistakes.

**Studies in Marketing**

**Problems of Elevator Management, Financing and Organization**

This study aims to analyze thoroughly the operating, financing and organization of farmers’ elevators in South Dakota with a view of finding possibilities of improving their organization, lowering their costs and improving their services.

A manuscript which has recently been given the printer is the first of a series and is limited to an analysis of the operating practices of elevators located in the spring wheat area of the state. The second bulletin which will be published during the next fiscal year will deal with a study of the organization of farmers’ elevators from the standpoint of economic set-up as it affects costs of operation and the stability of the enterprise.

The bulletin which is now in the hands of the printer deals with a ten-year period, 1921-22 to 1930-31. The elevators used in the study consisted of about thirty per cent of the farmer’s elevators in the counties concerned. In the intensive wheat area, one elevator was chosen for each one million bushels of wheat produced based on county production figures, while in the less intensive areas one elevator was selected for about half that production. Records from the same twenty-six elevators were used for the entire ten-year period with the exception that in 1926 one record was not available, in 1924 and 1927 two records, and in 1922 and 1923 three records were not available.

The most important tests of effectiveness used were expenses, net income, and economic profit. All the elevators were placed on the same basis
by considering the grain business as the important enterprise; all expenses in addition thereto were considered extra expenses, such expenses being only the actual additional amount necessary in order to carry the sidelines. The study has been largely based on bushel-volume groupings, because wheat and durum were the most important grains and these were combined with approximately the same other grains and in approximately the same proportions, causing the variations to be due primarily to variations in volumes handled.

The bulletin discusses the factors which affect returns in the grain business. These consisted of hedging, payment for protein and other quality factors, etc. Side-lines were divided into two general groups, general sidelines, which consisted of coal, flour, feed, twine, etc., and special sidelines, which consisted of gasoline and oil, machinery and hardware, and lumber. "Additional incomes" in addition to sidelines consisted of grinding, livestock handling, etc.

A review of the operations during the ten-year period, 1921-22 to 1930-31 reveals the fact that many elevators are experiencing a gradual decline in the amount of grain handled, while on the other hand a number are enjoying an expansion of grain growing in their territory. The logical planning for the future in the latter case would be to plan to handle grain as economically as possible, either increasing returns or reducing expenses, or both. In the former case, logical planning would involve being as efficient as possible but also and primarily to place emphasis upon increasing volume with sideline business to offset the decreasing grain-business.

The following summary table indicates the relation of average income, net income and economic profit to average bushels handled. It will be observed that the greatest differences occur in the lower volume groups, indicating especially the desirability of elevators with relatively small volumes to increase their volume either by grains or by sidelines.

<table>
<thead>
<tr>
<th>Volume group</th>
<th>Number of elevators (thous. bus.)</th>
<th>Average grain sales (thous. bus.)</th>
<th>Income per bushel</th>
<th>Net income per bushel</th>
<th>Economic profit per bushel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 100</td>
<td>60</td>
<td>62</td>
<td>.073</td>
<td>.014</td>
<td>-.031</td>
</tr>
<tr>
<td>100 to 200</td>
<td>37</td>
<td>148</td>
<td>.060</td>
<td>.011</td>
<td>.004</td>
</tr>
<tr>
<td>200 to 300</td>
<td>16</td>
<td>238</td>
<td>.050</td>
<td>.017</td>
<td>.011</td>
</tr>
<tr>
<td>300 to 400</td>
<td>9</td>
<td>350</td>
<td>.049</td>
<td>.018</td>
<td>.013</td>
</tr>
<tr>
<td>Over 400</td>
<td>6</td>
<td>465</td>
<td>.052</td>
<td>.024</td>
<td>.021</td>
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</table>

The bulletin indicates the relative profitableness of the various general and special sidelines and points out that too often sidelines are handled as an accommodation instead of on a profitable margin.

**Studies in Farm Prices**

**Correlation of South Dakota Prices and Production**

The computation of current index numbers of South Dakota farm prices was continued during the past year. The major part of the work on this project, however, dealt with the analysis of the reliability and adequacy of South Dakota farm price data, as collected and published by the Division of Crop and Livestock Estimates of the Bureau of Agricultural Economics, U. S. Department of Agriculture. The analysis was made in terms
of statistical measures or reliability. The price data analyzed were from the records covering the years 1927 to 1932, and included price samples of the most important South Dakota agricultural products. A special price inquiry was conducted to determine if there was any difference in the reliability of price samples obtained from selected vocational groups as compared with the regular reporters. Seasonal variation in reliability was observed by analyzing price samples by months. The effect of stratification was observed by the analysis of price samples by crop reporting districts. Prices as obtained from surplus producing areas were analyzed to determine their reliability.

The results of this study show that the price data from 1927 to 1929 are reliable enough for practical purposes when the reliability is measured in terms of the relative probable errors of not more than .50 per cent for less important products which is the standard of accuracy set up by the Division of Crop and Livestock Estimates. However, the reliability of the price data collected in 1931 and 1932, expressed in relative terms, is found to fall short of the desired standard as set up by the Federal Division. This is largely because the dispersions of price data do not vary in proportion to the decline in prices. When the reliability of the sample data is measured by an absolute measure, rather than by a relative, the reliability is practically the same for each year, except for some degree of unreliability introduced in 1932 by the decreased size of sample at that time.

With future samples equal in size to those of earlier years the data may be used with the same degree of confidence, since the absolute measures will very likely show comparable dispersion, even though the relative probable error will not meet the standard of accuracy under present conditions. This study indicates the desirability of lowering the standard or desired accuracy, as expressed in terms of relative probable error, for a low-price-level period.

The analysis of wheat, corn and hog prices from their respective surplus producing areas show sufficient reliability to warrant their use in studies of such surplus areas. Since prices computed for these vary considerably from the state averages it would seem desirable to compute separate surplus area series.

Studies in Land Economics

A Study of Land Valuation in Typical Areas of South Dakota

The purpose of this study is to develop a historical picture of policies of development, settlement and ownership of land; and to attempt to formulate better methods of land valuation.

It is the plan of this study to include land settlement policies, farm sales, assessments for taxation, appraisal for loans, rentals, census valuation and United States Department of Agriculture crop reporters' valuations. Comparisons will be made between various methods of valuation. Register of Deeds records, County Treasurers records, census records, U. S. Department of Agriculture, real estate sales and loaning organizations and the farmers themselves will constitute the chief sources of data.

Data covering more than 5,000 land transfers over a period of thirty years have been obtained in Brown county, South Dakota. Brown county was selected as typical of conditions in the spring wheat area. Some sup-
plementary data remain to be gathered, but progress is being made on the tabulation of data now available. The study has not reached the point where definite conclusions can be drawn.

Studies in Economics of Production
A Study of Farm Organization and Farm Practice in the Wheat Producing Areas of South Dakota

This study conducted in cooperation with the Division of Farm Management and Costs of the Bureau of Agricultural Economics aims to secure information on the organization and operation of farms with a view to developing farm organizations with higher income possibilities than those now prevailing.

About 120 farmer cooperators living in seven counties are now keeping cash accounts, and visits have been made according to schedule to secure information regarding the farm business organization and crop and livestock practices. Business statements of each farm for the year 1932 have been completed and sent to the Washington office for tabulation. South Dakota Experiment Station Circular 8, "Emergency Farm Adjustments in the Wheat Area of South Dakota," is based on this study and was published this winter to supply information for emergency use. Special reports and analyses have been made up from time to time for use in extension work.

The project entitled "A Study of Farm Organization and Management in Area VI", has been merged with this study. From material gathered in both of these studies a report on the use of tractors and horses was prepared and published as South Dakota Experiment Station Circular No. 6, "Tractor and Horse Power in the Wheat Area of South Dakota."

Conclusions may be enumerated as follows: The greatly reduced income of many of the farmers of the area necessitates a corresponding decrease in operating and personal expenses if the farmers are to retain their equity in their business. This is especially true of farmers with relatively high indebtedness.

Adjustments made to date for the purpose of meeting the situation include: restricting production to reduce cash costs; or on the other hand, increasing production, and at the same time increasing the risk, to secure greater gross income; reducing the expenditure for family living; reducing capital assets to meet payments on indebtedness; using family labor more; increasing the relative area of cash grains; intensifying operations through change from raising cattle for beef production to the production of dairy products; and in some cases, relinquishing title to a farm to become a renter. Only farmers who are relatively free from debt can reduce operations and wait for an improvement in prices.

The above adjustments are of an emergency nature and are made in order to survive the depression. They may differ considerably from what would be the most profitable organization and practices under more normal price conditions.

Conclusions regarding the use of tractors and horses may be stated as follows: The average total cost per acre of farming with tractor and horses on farms averaging 469 crop acres was approximately the same in 1930 as the average calculated total cost per acre of farming with horses on farms averaging 347 crop acres. The cash costs per crop acre averaged 60 cents with tractors and 7 cents with horses. The rate of performance of tractors was from 30 to 50 per cent faster than the rate of horses draw-
ing implements of similar sizes. The investment in equipment and power for producing crops averaged approximately $5.80 per acre on horse farms and $6.70 per acre on tractor farms. This figure included belt driven machinery on the tractor farms. No one of these differences, or other differences studied are sufficient bases for a choice between using horses or using tractor as major power on a farm. Net returns to the farm should be the basis of choice. Circular No. 6 illustrates methods of making decisions regarding use of horse and tractor power.

A Study of Cattle Ranch Organization and Management in Northwestern South Dakota

The purpose is to study trends in cattle ranch organization and management over a period of ten or more years. Twenty-five cooperators are keeping records for the third year, visits have been made according to schedule, and the preliminary report for the second year is now being written. The number of visits per year has been reduced to one because of shortage of funds.

Ranches with the lowest percentage of indebtedness in comparison to their total capital investment have been affected less by the depression than those with high indebtedness in comparison to investment. As prices declined since 1930 the tendency has been to hold aged cows and light weight steers that would otherwise have been sold.

Inactive Projects

Work has been postponed on certain projects of the department in order to give more time to those projects which seem of greater immediate urgency. Very little work was done this past year on The Study of the Elements of Risk and Uncertainty in South Dakota Agriculture. The work was shifted to a greater emphasis on completion of some phases of the credit study. Work on the project entitled, "Large Scale Farming in South Dakota," has also been postponed in order to devote more time to the emergency aspects of the Wheat Area Study.

Work on the Transportation Project was completed during the fiscal year 1931-32, but the manuscript on truck transportation has been held over and will be published during the present year.

Agricultural Engineering

By Ralph Patty

The Use of the Combine Harvester-Thresher (Purnell)

Because of the fact that the grasshoppers cut off many of the heads, hot and dry, the work for these years was repeated with the hope of getting a season that would qualify as average for South Dakota. Although the rainfall this year was nearly normal, the weather during harvest season was excessively warm with only .05 inch of rain during the time this work was carried on. This season must, therefore, be classed with the past three seasons, that is, not average for South Dakota.

The weediest oat field available near the college was used and the work was outlined in order to get more data and possible comparisons on the use of the windrower in weedy and weed-free fields.

Conclusions:
Because of the fact that the grasshoppers cut off many of the heads, it was impossible to make accurate loss counts.

The field required 6 days from the time the binder started to reach the point where straight combining was allowable. While it required a longer time by a few hours for the heavier windrows to dry out, they showed less variation of moisture content over night or during light showers.

Windrowed grain required two days to dry out to maximum allowable moisture content, while the standing grain required five days.

In hot dry weather windrows can be picked up as early as 7 a.m.

Two weeks after the first cut was made, practically all the uncut grain was down but not shattered noticeably, while windrows were in excellent condition at the end of two weeks.

The heavy growth of weeds did not interfere with the operation of the windrower but were not handled readily by the platform canvas but were passed on to the cylinder in bunches, and the combine failed to remove all the broken weed stems from the oats.

This year's work showed that the problem varies according to the kind of weeds in the grain.

This field was the weediest one worked with, but when properly handled weeds affect the moisture content of the grain less than was expected as judged from previous work, due probably to the kind of weeds. The tall weeds encountered this year are the first to interfere with the handling of the grain by the platform canvas.

**Rammed Earth for Farm Building Walls (Purnell)**

A study was made during the year to find the optimum time to paint a pise wall after the forms are removed. Small weathering walls were painted at intervals beginning immediately after the wall was finished and up until 90 days later. Walls that were painted immediately are showing quite satisfactorily when favorable dirt is used. Five to seven days after the forms are removed seems to be the optimum time for the priming coat. The advantage in painting as soon as possible is in getting a smoother surfaced wall. When let stand for 30 to 60 days an unfavorable soil will begin to crumble and in the same length of time the surface of a wall built from favorable soil may be roughened by driving rains.

A careful study made on a series of test pieces showed the shrinkage of pise walls to vary directly with the amount of moisture that was present in the soil when rammed. The curve developed on this was almost a perfect curve. Since the optimum moisture content is reduced as the amount of sand present in the dirt increases, the shrinkage also varies inversely with the sand that is present.

Shrinkage in pise walls opens the joints and causes cracks to develop. The total lineal space that will open in the cracks and joints of a long wall can be figured quite accurately when the shrinkage coefficient for the dirt used is known.

A poultry house was constructed with pise or rammed earth walls and used throughout the winter season. Temperature readings were taken in the house and comparisons of temperature and frost conditions made with other houses of similar dimensions and housing the same number of birds.
The temperature in early morning averaged from three to five degrees higher in the earth house. The frost condition on the inside walls was decidedly in favor of the earth house also. Experiment Station bulletin No. 277 was written during the year on the progress of this project.

**Corn Harvesting Machinery (Purnell)**

Work on this project for the year was greatly reduced due to early snow and cold weather. A study of field losses in corn harvesting was just well under way when heavy snow stopped the work for the season. The husker-elevator machine which has been built under this project works satisfactorily but will be improved during the coming year.

**Field Machinery Hitches for Tractor and Large Horse Teams (Purnell)**

This is divided into two parts.

**Part I.** A study of big team hitches with emphasis on the fundamental design of the single-tree. A study of the most practical material and shape of single-tree with particular attention to the size, shape, material and method of fastening of hooks. The idea is to design a single-tree that will give maximum service yet be light in weight, and of such shape and design that the average farmer can select a good piece of wood, make the single-tree and mount the hooks and center clip. Double-trees and eveners will be studied in the same manner.

**Part II.** A study of different types of hitches designed to pull two or more implements, with the idea in mind of building a simple hitch that will handle easily, be economical to build and be adaptable to a wide range of implements. The construction of this hitch will be such that the average farmer can build it. Special hitches will be developed to offer a method of pulling two or more machines by either horse or tractor power as a temporary practice.

This project is just starting and work so far has consisted in making and breaking test pieces of four different kinds of wood in order to learn more about woods, and design of single-trees. The equipment for breaking test pieces, for measuring pull required to pull off or break the various kinds of hooks, and for determining effect of different hook fastenings on strength of single-tree is set up and operating. While there are no major conclusions to report some things that have been noted are that the selection of material from which to build single-trees is very important. Hickory single-trees cut from the same plank varied in strength according to the amount of heartwood present. As the amount of heartwood increased the strength of the piece decreased.

**The Comparative Length of Service of Galvanized Steel Posts and Painted Steel Posts (Station Local)**

The inspection of the galvanized steel posts set in the fence eight years ago shows them to be in perfect condition. The painted posts are rusting rapidly. More than one-half the paint is gone from them.

Four different kinds of paint have been used in repainting certain blocks or lines of these posts. The paints used were metallic zinc paint, Snolite, white lead paint, and Minnesota O. S. paint. Records were kept on the amount of paint used per steel post in painting them.
Rammed Earth in Poultry House Construction
(Station Local)

Temperatures were taken in the earth house and in a house similar in size and in number of birds, with similar straw loft and inside arrangement but with frame walls. Some changes were made in the location of thermometers during the winter months and the study will be continued under better controlled conditions during the coming year. The earth house showed an advantage in both frost conditions and in early morning temperatures with a decidedly less fluctuation of temperatures during the 24 hours of the winter days.

Agronomy
By A. N. Hume

Corn Rots (Adams)

Within the present fiscal year certain results from this investigation have been published under the title "The Germination of Seed Corn and Its Relation to the Occurrence of Molds During Germination," bulletin 275. The results established the fact that the correlation between the occurrence of molds on germinating kernels of seed corn over a period of five separate years was consistently negative, that is, higher percentages of mold were correlated with lower percentages of germination and vice versa. The variation between the several years was considerable, extending from $-0.1505 \pm 0.0566$ to $-0.7705 \pm 0.0274$.

Additional reports on this project are being prepared relating to other phases of correlation between corn rots and characters of corn relating to yield. Among characteristics being investigated at the present time it that of root development as indicated by amount of pull necessary to remove corn plants from the soil.

Carbohydrate Variations (Purnell)

The publication of bulletin 270 related to the apparent influence of light and temperature between day and night upon carbohydrates, namely, sugars and starch.

At the present time the apparent influence of soil factors upon carbohydrates in corn plants is being investigated. One series of pot experiments has been completed with the use of Pierre clay soil taken from a locality where soil treatment with phosphorous apparently had decided influence upon color of corn plants during the season of 1931.

Cereal Breeding for Rust Resistance (Purnell)

This project has produced results throughout four seasons wherein plants have been produced in the greenhouse and also in the nursery. In the present season fifty-six hybrids were placed in the nursery in comparison with standard varieties as part of this investigation. In spite of conditions of drought all observations that are possible are being made especially concerning the characters of earliness versus late maturity. The nursery observations are seriously interfered with at the present time by lack of rainfall.
Re-selections were made by K. H. Klages from (Kota x Marquis) x (Marquis x emmer) and Marquis x emmer) x Reward crosses in an attempt to obtain early maturing high yielding strains. In crosses between early and late maturing types earliness was found completely dominant over lateness. This spring 77 spring wheat hybrids were included in the yield nurseries at Brookings and Highmore.

Crosses between winter and spring (Marquis x emmer) types made for purposes of rust inheritance studies showed a segregation of approximately 15 non-hardy to one hardy in F². In F¹ the spring habit of growth was completely dominant over winter habit.

The work on barley is limited to the testing of standard varieties and selections from such varieties. Numerous foreign introductions of barley were also tested. Several selections made from Odessa show considerable improvement in strength of straw found in the original parent. The high yielding selection of Trebi has been isolated.

Standard varieties and double crosses of oats resistant for both stem rust and smut produced by Mr. Fowlds are being tested in the nursery and variety test plots.

**Soil Fertility (Adams)**

A long time project on the influence of rotation upon the maintenance of soil fertility involves the use of a definite rotation with fertility treatments.

1. Crops grown and harvested and weights recorded as per project.
2. Phosphorous, calcium, magnesium, and sulphur determined in the three layers — 0-7 inches, 7-14 inches, and 14-40 inches on plots 150 to 159, and the potassium on plots 150-154. This completes the analysis of the last sampling, with the exception of the potassium on plots 155-159 inclusive.
3. The results of the first twenty years investigations under this project have been published in bulletin No. 280. These results show that phosphorous has increased the yield of total dry matter, as an average, for the entire period, of 1979 pounds per acre or 32.08% above the yields obtained from the untreated land. The yields due to the application of phosphorous were larger than for any other treatment.
4. Soil prepared, fertilizers applied, and crops seeded for 1933.

**Phosphorous and Sulphur (Adams)**

A project was designed to define accurately the effects of phosphorous in different forms on the growth of plants, and the effect of sulphur in combination with calcium carbonate (gypsum, calcium sulphate) and pure sulphur on the growth of plants.

1. Greenhouse pots grown, harvested, and recorded in 1932. Soil series only.
2. Pots planted in 1933 and harvested.
3. Tabulation of records under way.

**Weed Eradication (Hatch and Local)**

Within the present fiscal year some progress has been made with learning methods for the eradication of creeping jenny (Convolvulus arvensis) which is apparently one of the most difficult, if not the most difficult, weed pest in South Dakota. In previous reports attention has been called to the
possibility of eradicating creeping jenny with the use of a solution of calcium chlorate applied in the form of water dust at a stage of growth not earlier than blossoming. More recent investigations have indicated that even more effective and more economical results may be secured with delaying the time of spraying until late fall, even the latter part of October or the first of November. Apparently at least under some circumstances such late season spraying accomplishes with one single treatment as much or more than one treatment which necessarily includes spraying at earlier stages of growth.

Some progress has also been made with cultural methods including the use of smother crops which have been utilized in connection with a regular rotation of (1) corn, followed by (2) wheat, followed by (3) sweet clover. Two different smother crops have been introduced into this rotation following the sweet clover, namely, winter rye and sorghum. Either or both of these smother crops thus introduced offer some indication that they may be effective in holding creeping jenny in check if not of eradicating it.

Eradication methods for other perennial weeds are likewise under investigation.

**Crop Rotations (Hatch)**

Crop rotations experiments have been continued for many years at Brookings. A summary of crop yields which this department hopes to compile as early as possible will constitute statistical data measuring the variations of yield due to season and soil and environmental conditions to which crops are naturally subjected. Such data may furnish a scientific basis for other discussion.

The widest variations due to differences in crop rotation seem to be effected by weed population.

Thus a study of crop rotations coordinates with studies in weed eradication.

**Flax Investigations (Flax Scholarship)**

Flax investigations have included tests of several varieties with a view to observing one or more which may be free from diseases, especially flax wilt and rust. To date the variety Buda has proved most dependable.

At the present time in addition to previous experiments with flax some investigations are conducted with the effect of soil treatment on the yield and quality of flax. Heretofore nearly all research which has been possible to carry out has been done as nearly as possible with conditions which equalize factors of soil fertility. Consequently there is room for a good deal of information on that point. One problem is being pursued under the direction of J. G. Hutton, with student assistant Mr. Stockland, involving soil treatment of flax with the usual fertility elements and magnesium in addition. The project calls for a determination of the relative effect of these several treatments on the yield and quality of flax and especially percentage and drying quality of oil.

**Seed Testing (State)**

The seed laboratory tested 1624 samples of seeds, and 246 weed specimens were identified.
Substations: Highmore, Eureka, Cottonwood, Vivian (State)

During the present fiscal year the printing of a limited edition of bulletin 272 has been completed and is now ready for distribution to those who make inquiry for this tabulation, entitled "Crop Yields Over Nineteen Years from Highmore Experiment Farm." It has been suggested that these tabulated yields extending over a comparatively long period may contribute to information serving as a basis for land appraisal in the section of the state which they represent. Seasonal variability in crop yields gives rise to the necessity for results extending over a long term.

Publications of similar results covering a period of ten years were published some years since from Vivian Experiment Farm, in bulletin 253, entitled "A Decade of Crop Yields from Vivian Farm." Similar results covering twenty year periods are being made available from Cottonwood and Eureka Experiment Farms.

It has been found necessary to discontinue a large number of cropping systems at the several experiment farms due to limited income. If these can be restored at a reasonably early date the computation of crop yields covering continuous seasons may not be so greatly disturbed.

Potato Investigations (State)

A limited state appropriation is available for the specific purpose of potato investigators. This is supplemented with the use of Hatch funds and Local.

Tuber index and tuber unit work is being carried out with three varieties, namely, Irish Cobblers, Early Ohios, and Triumphs. In addition twenty different varieties are tested for their adoption to South Dakota conditions.

Experiments are also in process dealing with the control of insect pests by spraying.

Forage Crop Investigations (State and Local)

Within recent years it has been necessary to give increased attention to the investigation of drought and grasshopper resistant forage crops. It was observed at Vivian Experiment Farm in 1930 that flint corn (Rainbow) was much more resistant to grasshoppers than dent corn (Vivian 13 and All Dakota). In 1931 likewise it was demonstrated by seeding sorghum (Grohoma) in alternate rows between corn rows that the sorghum was decidedly more grasshopper resistant than dent corn. Continued investigations in the present season have confirmed the foregoing indications and in the meantime investigation of various types of forage crops, especially sorghums, has been enlarged as much as possible. At Vivian the cultural experiments with seeding sorghum in alternate rows with corn for silage purposes have been continued. At Brookings increased attention has been given to the development of types of sorghums which may be sufficiently early in maturing seed for South Dakota conditions and which may likewise yield the highest amount of forage and seed for feeding. The characters of earliness and seed bearing qualities in South Dakota are barely early enough to mature seed under the usual conditions of growth. Eighty types of sorghum have been separated by Franzke by methods of selfing. These are mainly types of Amber cane. Numerous crosses of selfed types have likewise been made. The theoretical and practical problems connect-
ed with forage, especially sorghums and sudan grass, are of much practical and scientific interest.

Many inquiries have been received by this department concerning the cause and possible prevention of the poisoning of livestock by sorghum (prussic acid). These inquiries are being answered on the basis of information now available. Numerous chemical tests of sudan grass and other sorghums have been carried out in the Agronomy laboratory by Leo F. Puhr, in order to make direct replies to inquiries, and additional investigations along this line are being planned.

The following list of bulletins and circulars have been issued during the past year by members of this department:

Bul. 272—Crop Yields over Nineteen Years from Highmore Experiment Farm.
Bul. 275 The Germination of Seed Corn and Its Relation to the Occurrence of Molds During Germination.
Bul. 278 Winter Wheat in South Dakota.
Bul. 280 The Results of Twenty Years Complete Soil Fertility Tests at Brookings, South Dakota.
Reprint—Soil Survey Circular No. 1.

"Observations upon Yields of Staple Crops over a Period of Nineteen Years on the Highmore Experiment Farm." A. N. Hume. Proceedings South Dakota Academy of Science.


Animal Husbandry

By James W. Wilson

The following experiments in feeding and breeding livestock were conducted during the year:

Cattle

The Value of Ground Flax and Ground Soybeans in the Production of Baby Beef (State)

At the close of the fiscal year there were 25 head of calves in five different lots of five head each in the yards. All lots received shelled corn and alfalfa hay. Lot I was the check lot and received no supplement. Lot II received linseed oil meal; Lot III ground flax; Lot IV soybean oilmeal and Lot V ground soybeans. At the end of the 150 day feeding period these calves had practically doubled their weights and yet they were not as fat as desired by the market.

Judges of finished livestock on hoof, after examining these calves close-
ly, claimed that the results indicate that the feeding of a supplement with the corn and alfalfa hay is an advantage.

**Sheep**

There were four experiments with sheep; one in fattening lambs, two in breeding and one in curing mutton. This was the third year for the fattening lamb experiment and bulletin 278, April 1933, was printed giving results in detail. The methods of feeding and the grain rations are important factors in lamb feeding.

**A New Breed (State)**

In the breeding experiment to eliminate the tail, the results were very encouraging. Of the 53 lambs born in the spring of 1933 there were 15 that had no tails, 25 that had tails less than 2 inches, 9 with tails between two and three inches and four with tails between three and five inches. It was not necessary to cut off any tails. In addition to this tailless and short-tailed feature, indications are that this breed of sheep has other superior characters over breeds we now have, such as quality of wool, hardiness and open face. As far as we know, this is the only breed of no-tailed and short-tailed sheep with other desirable characters in the world. Inquiries about this new breed have been received from many sections of the United States and one from Edinburgh University, Scotland, which is an indication that people are interested in the experiment.

**Karakul Sheep (State)**

The other experiment in breeding is with the Karakul sheep. The Karakul lamb when killed at an early age furnishes a fur which is used largely for trimming women's dresses, and coats for winter wear.

With our climatic conditions, we shall always be in need of furs to protect us in winter, and as a result this fur will be in style.

There is an opportunity for a valuable industry to be established along this line, but at the present there are not enough Karakul sheep in the country to warrant the establishment of such an industry. Results of the different crosses of the Karakul rams and other breeds show that furs could be produced with a natural lustre superior to many now being worn. The results also show that a better quality of fur is received with several crosses of the Karakul. An additional drawback to such an industry is the absence of a market for the fat Karakul lamb, or the one that does not have a suitable fur for commercial purposes.

The feeding qualities of these new breeds and the Karakul lambs will be tested out.

**Devising and Comparing Methods of Curing Lamb and Mutton and of Utilizing the Cured Product (Local)**

This experiment was undertaken in the spring of 1933. At the present time there are six different lots in the cure and the intention is to sample the mutton by a sampling committee.

**Swine**

There were five experiments in feeding swine.

1. **Rations for Spring Pigs after Weaning (Hatch)**

The object of this experiment is to obtain information as to the growing and fattening of the pig, mostly on forage plants. Because of the drouthy conditions the results do not justify drawing conclusions. This is the third season for this experiment.
2. How Can Soybeans be Fed with Corn to Avoid Soft Pork? (Purnell)

Forty head of spring pigs were divided into five uniform lots and fed with either tankage or raw, roasted, boiled or soaked soybeans along with corn, alfalfa hay and minerals until the pigs weighed 150 pounds, and then were finished to a market weight of 225 pounds with the soybeans omitted. The carcasses were graded for firmness and fat samples were taken for chemical analysis.

Soft pork cannot be avoided entirely by preparing soybeans by any of the methods used in this experiment plus a hardening feeding period from weight of 150 to 225 pounds. Roasting or boiling soybeans renders them more palatable to pigs.

3. The Value of Oil of Chenopodium in the Treatment of Pigs for Ascards (Purnell)

(In Cooperation with Department of Pharmacy)

There were 6 lots of pigs used. They were infested with worms at the beginning of the experiment. Pigs in Lot IV were wormed early. Pigs in Lot I were not wormed but pastured on chenopodium and rape and oats. Those of Lot II were not wormed but were given only chenopodium as a forage plant. Pigs in Lot III were not wormed and used as the control group. Pigs in Lot V were wormed once. Those in Lot VI were wormed twice. All pigs except those in Lot II had access to rape and oat forage and all lots received a grain ration of shelled corn and ground barley mixed equal parts by weight.

Results, as in the 1931 trial, indicated that it did not pay to worm pigs twice. The pigs in Lot II receiving the chenopodium plant as forage showed fewer worms when butchered than pigs in any of the other lots. The gains made by these pigs, however, were a trifle more expensive than gains made by pigs in Lots V and VI.

4. The Value of Ground Flaxseed in the Production of Pork (State)

Six lots of fall pigs were used in this experiment. Results thus far obtained indicate that ground flaxseed is not so efficient as a protein supplement such as tankage or linseed oilmeal. Results also indicate that carcasses of pigs so fed are not as firm as carcasses of pigs fed the highly protein supplement.

5. Fattening Summer Pigs on South Dakota Grains (State)

This is an experiment to determine the value of mixing rye with other grains for fattening pigs. The fastest gains were made by the pigs fed the corn and rye and the barley and rye mixtures. From the standpoint of economy of gain, the rye and corn mixture proved slightly superior to the barley and rye mixture. Results also indicate that rye as a sole ration is a poor feed for fattening hogs.

This department is cooperating with the Federal Station at Newell, South Dakota, in feeding by-products of the sugar beet factory to lambs and pigs.
Department of Chemistry
By K. W. Franke
Alkali Disease Project (Purnell Fund)

Various types of work are being carried out in the attempt to isolate and identify the toxic factor involved, also the effect of this toxic compound on the metabolism of the animal, its growth and reproduction. Experiments were made in which 5, 10, 20, and 40 per cent of affected grain were used in the diet in order to find out what effect beneficial or otherwise smaller amounts of the grain might have in nutrition. Although this part of the work has not yet been completed, all indications point that there is no beneficial effect from the addition of small amounts of this grain to the diet, and 40 per cent prevents reproduction beyond the first generation. In the case of the rats taking 20 per cent of the affected grain in the diet, decreased growth and loss of hair on some animals was observed. A final report cannot be given at this time as this work is still in progress.

In the performing of post-mortems on about 1200 rats, it was observed that the blood in many cases was abnormal. On this basis it was felt that a study of the composition of the blood might help to determine the toxic factor involved.

The blood studies have revealed that a pronounced anemia (low hemoglobin and red cell count) develops in the majority of affected rats. This anemia develops progressively and extends over a relatively large period of time. Accompanying the low hemoglobin levels are marked disturbances in the ratio between the various types of white cells. The red cells are greatly changed as to size and shape, and the blood plasma is very icteric.

The non-protein and sulphur-containing constituents of the blood are being studied because experimental work has shown that the alkali disease seems to involve either or both protein and sulphur metabolism.

The changes in both the cellular and chemical constituents of the blood are almost certainly dependent upon damage to the liver and the hematopoietic system as a whole. This type of pathology is caused by a variety of poisons which include lead, mercury, phenyl-hydrazim and snake venom.

As the toxic factor was found to be linked with the protein portion of the grain, the protein is being decomposed into simpler constituents and separations made in the attempt to isolate the toxic factor. Some segregation of the toxin has been obtained but the work has not continued far enough to give a definite report on this phase. As it is practically impossible with funds available to make separations with large enough amounts so that the various constituents could be separated and be fed to even as large an animal as the rat, the attempt has been made to develop biological tests for the toxicity which will require only very small amounts of material and which can be performed in a short time. It is also very desirable that this test be a measure of the degree of toxicity present in any fraction of the protein. This part of the experimental work has been confined largely to the effects of the isolated proteins and fractions thereof, from control and affected grains on enzymes and fresh water organisms such as the paramecium and daphnia. The experiments with the enzymes show that the affected protein retards the action of zymase, invertase, pepsin, trypsin, and erepsin. Indications are that either the paramecium and daphnia may also be used as a bio-assay method. The value of both of the above
procedures can only be determined by determining all factors that will affect them and finally by checking with a large number of affected food-stuffs. This is being done at present.

In Cooperation with Poultry Department

In the feeding of affected grain in determining its effect on growth and reproduction is being carried out, and details of this work will be reported by Prof. W. C. Tully.

Soy Bean Experiment (Purnell)
Cooperative with Animal Husbandry Department

Extractions of lard have been made of all the hogs killed this year and refractive index determinations are being made.

Studies in Calcification (Hatch)
Cooperative with Poultry Department

In the feeding of different calcareous materials to chickens, there were indications that some materials may effect egg production and egg shell strength, especially when the hens' calcium reserve has first been removed. Chemical analysis failed to give any clue to explain these effects. Therefore, an attempt was made to carry out potentiometric titrations under conditions similar to those of the gastro-intestinal tract of the chicken, but so far this work has not been carried far enough to give any definite conclusions. Curves obtained by plotting the pH against time (after the addition of acid) were very similar, except for that of one limestone, a dolomitic limestone. The curve of a sample of pure CaCO₃ showed a much more rapid increase in pH than did any of the limestone. These studies are being continued at the present time.

Dairy Husbandry
By T. M. Olson

A Comparison of Sweet Clover, Alfalfa and Sudan Grass Pastures Under South Dakota Conditions (Purnell)

Six pasture seasons have been completed. The results of the first five seasons have been published in bulletin No. 265. Two plots of permanent pasture mixtures were added this year. These plots were seeded in early June, but due to drought condition no stand resulted. The plots are being plowed and will be reseeded.

Rye pasture was added last year as an early pasture crop. From the standpoint of carrying capacity and palatability rye pasture was very satisfactory. However, we found rye did produce an objectionable flavor in milk even when the cows were on the pasture only six to seven hours a day and taken off two and a half to three hours before milking.

During the 1932 pasture season there was no alfalfa. The stand had been killed during the fall and winter.

The sweet clover and Sudan grass showed the highest production for the six-year-period, during 1932. The sweet clover produced 260.9 pounds of fat per acre for a pasture season of 109 days. The sudan grass pasture produced 133.8 pounds of fat per acre for 89 days pasture season.

Much interest has been manifested in cultivated pastures by farmers, extension workers, and agricultural publications. A pasture campaign is
being fostered by the Dakota Farmer. Accurate information on this subject is therefore important and vital.

**Amino Acid Titration as a Measure of Quality in Dairy Products (Hatch)**

A series of trials has been completed, using the Sorenson titration and the Van Slyke analysis.
These methods of analysis are applied to cream, buttermilk and butter when fresh, and on butter at six months intervals during storage.
The results to date indicate a correlation between amino acid content and quality when the deterioration in quality is due to age, with its accompanying factors. However, if the poor quality results from the introduction of undesirable flavors the analyses is not indicative of market quality.
This project is completed and the material is in the process of compilation.

**Variation in Calcium and Phosphorus Content of Cow’s Milk (Hatch)**

The milk from twenty-four cows has been analyzed at 15-day intervals. The analysis is made regularly from the first milking after freshening until the end of the lactation period.
The following analyses are made: total ash, calcium, phosphorus, fat and total solids content.
This project has been in progress for ten months. The analyses does not include complete lactation periods but will be continued until complete analyses are available on thirty to forty lactation periods covering all seasons of the year including pasture and barn feeding.
Observations are being made on the influence of the season, feed, stage of lactation, and breed of cows on the composition of the milk with special reference to the variation in the calcium and phosphorous content.

**Some Routine Tests for Garget or Mastitis in Cows (Station Local)**

A number of tests designed for the detection of mastitis in cows’ milk have been applied on fifty-four cows in the college herd. Samples have been secured from each quarter in every case so that a record is made of the condition of each quarter on every test.
The results so far indicate that the tests applied on the milk are valuable in detecting cows which are dangerous as spreaders of the disease. In many cases no abnormal appearance of the udder or of the milk could be detected by the milker, but the laboratory tests indicated a diseased condition. The disease appears to be recurrent, hence the value of the tests is in isolation and ridding the herd of the sources of infection. The results to date do not seem to indicate any relation between the garget infection and contagious abortion infection.

**Foam on Skimmilk vs. Skimmilk for Dairy Calves (Station Local)**

Three trials were conducted with six calves in each trial. The data have been compiled and published in station bulletin No. 273.
The following conclusions appear in the bulletin:
1. If the skimmilk and foam are fed to the calves in a definite weighed amount the calves on skimmilk and foam will make as good gains
in body weight as skimmilk fed calves, and will increase in height at the withers at the same rate as normally fed calves.

2. The calves may bloat slightly after drinking the skimmilk and foam but no bad after affects are apparent.

3. The trials indicate that it is a safe practice to feed calves the foam which normally collects on separated milk provided a definite amount by weight is fed.

4. It is believed that most of the trouble from the feeding of skim milk with foam results from over feeding rather than from the foam itself.

**Ice Well (Station Local)**

This is a cooperative project between the Dairy Department and the Agricultural Engineering Department.

It has been difficult to freeze ice in the well. During the winter of 1933 special effort was made to get ice by throwing in the well slush ice. By this means a cake about three feet in depth was secured. When the well was used for refrigeration the middle of June much of the cake had melted, particularly on the edges.

The results to date would indicate that if one can get a good cake of ice in the well that it would be a practical and convenient method of refrigeration on the farm. Milk and cream was kept in sweet condition for five days of the hottest weather.

Our experience to date would indicate that it would be more practical to freeze cakes of ice in the open, and store them in the well.

**Alfalfa vs. Sweet Clover Hay (Station Local)**

The chemical analysis of alfalfa and sweet clover hay are about the same, therefore the feeding value of the two legumes should be about equal.

A feeding trial was conducted with twenty milking cows in which alfalfa and sweet clover were fed in such amounts as the cows would consume. The grain and silage part of the ration remained the same.

The results show that if sufficient sweet clover is fed so that cows are allowed to chose only the finer parts of the sweet clover hay the production will be maintained. The refused sweet clover under this plan of feeding averaged 40 per cent by weight of hay fed. The sweet clover fed in this experiment was cut with a binder and well cured. It is recognized that the method of cutting and curing would be an important factor in the amount refused.

**Holding Cream Raw and Pasteurized (Station Local)**

Fifty-one churnings have been run on cream held raw and held pasteurized for periods of 40 hours. The butter has been stored at 0°F. and scored when fresh and monthly thereafter.

The results indicate a very decided improvement in the scores of the butter made from cream which was held raw as compared with the butter made from the cream held 40 hours after being pasteurized. The improvement in score averaged approximately 1.5 points. The greatest difference was in cream of high acidity.

This experiment will be continued until all churnings have been in storage for at least six months.
The Vitamin D Content of Milk from Cows Exposed to Sunlight, Green Grass, and no Sunlight (State)

The milk from cows kept under these various conditions was fed to groups of white rats. The rats were fed specific amounts of the milk twice a day.

The rats were weighed daily and at the close of the experiment the femur and tibia of the hind legs were freed from flesh, ground fine and ashed.

Two trials have been run and although the difference was not great, the milk from cows on green grass proved superior in vitamin D potency to the milk from the cow in sunshine and markedly better than the milk from the no-sunshine cow.

These trials seem to indicate that green grass together with sunshine are important factors in increasing the vitamin D potency of milk.

Vitamin D Potency of Butter (State)

Butter from cream produced under summer conditions was compared with butter from cream produced under winter feeding conditions. The vitamin D potency of the butter was determined by feeding the butter to groups of white rats.

The rats were killed after a thirty day feeding period, X-rayed, and the femur and tibia dissected out and ashed.

Both the X-ray photographs and the per cent of ash showed considerable more calcification with summer butter than winter butter. The butter was fed on two levels—5 per cent of 10 per cent by weight of rations. The following table of ash percentages indicates the results:

| Basal ration—average of 5 rats | 28.829% ash |
| Basal ration plus 5 per cent winter butter | 37.059% ash |
| Basal ration plus 10 per cent winter butter | 40.619% ash |
| Basal ration plus 5 per cent summer butter | 43.436% ash |
| Basal ration plus 10 per cent summer butter | 46.561% ash |

The X-ray photographs checked very closely with the ash analysis. These trials are being repeated.

Cross Breeding Experiment (State)

We have one complete lactation on nine F₁ crosses. Three cows have completed two or more lactations. One F₂ heifer has completed one lactation period. We have three F₃ heifers, and one F₃ heifer to freshen.

The F₂ crosses are mostly red and white in color, and have characteristics of both the Jersey and Holstein breed. The per cent of fat in the milk is about the same as the F₁ cross or an average of the two breeds. The per cent of fat in the F₂ cow which has one complete lactation period ranges from 3.4 to 4.5 per cent with an average of 3.9 for the lactation. Her F₃ dam had an average of 4.5 per cent for the first lactation period.

Oat Feed vs. Roughage for Dairy Cows (Station Local)

Two trials have been conducted in which oat feed was compared with wild hay as the sole dry roughage. Wild hay was used in this comparison because of the similarity of analysis of the two feeds and second, because the relative feeding value of wild hay is well known by livestock feeders in South Dakota.
The data from these trials have been prepared for a station bulletin. The following conclusions are significant:

1. Oat feed can be used as the sole dry roughage for dairy cows.
2. Oat feed is comparable with wild hay in the maintenance of live weight.
3. Good quality wild hay is slightly more efficient pound for pound in maintaining milk and fat production.
4. When oat feed can be purchased at a price equal to or lower than that of good quality wild hay its use for roughage for dairy cows can be recommended.

Home Economics
By Edith M. Pierson

NUTRITION
A Review of Methods Used for Diagnosis of Scurvy
In Experimental Guinea Pigs (Purnell)

The work of the past year has been a comparison of three methods used for diagnosis of scurvy in guinea pigs, the Sherman, Tozer, and Hojer and the addendum fed was commercial canned spinach in graded doses of 5, 10, 12 and 15 grams per guinea pig per day. Ten animals were used for each dose and in the Sherman Method the animals were autopsied and scored according to that standard. Histological sections were made of the teeth and ribs of these animals.

In the Hojer method and a modification of the Tozer method, the animals were allowed to run for 20 days on the Sherman LaMer basal diet plus graded amounts of the canned spinach. Tooth and rib sections were made from every animal.

Weights of animals were recorded of negative and positive controls, as well as the experimental animals. Ten and 15 grams of canned spinach per day give as good growth as the positive controls, the 5 grass dose falling off only slightly. The total average weights to date (75 days) for the 5, 10, 12, 15 grams and positive controls are as follows: 256, 328, 184, 321 and 291 grams.

The 12 gram average weight curve is out of line and this may be due to the greater number of female guinea pigs used for that dose. Another series will be run with male guinea pigs on the 12 gram. Ten of the 20 guinea pigs on 12 gram died in the course of the experiment from colds, pneumonia, etc., and these were not included in the average.

The experiments are not complete. However, preliminary results indicate that the Hojer tooth method is a more sensitive indication of presence of scurvy than either of the other two methods.

An examination of some of the 20 day animals on the Tozer method shows that there is a breakdown of the cells in the costechondral junctions while the teeth of the same animals show no scurvy.

Results to date show that the Sherman unit is 5 grams and the Hojer method unit is around 10 grams. These results may change slightly when final data are in.

Two of the advantages of the shorter methods are that the loss of guinea pigs from colds and pneumonia is not as great as in the 90 day period and short season fruits and vegetables can be tested in the fresh state.
Textile Project

The Influence of Various Grades of Wool on Some of the Physical Properties of Flannel (Purnell)

The wool was purchased from the Animal Husbandry Department. Fleeces from lambs of the following breeds were used: Shropshire, Rambouillet, Crossbred, Grade Karakul, Southdown and Hampshire.

The following subjects were studied:

1. Crimp
2. Length of fibre
3. Diameter of fibre (Caliper and microscope)
4. Yarn Count
5. Twist
6. Strength of Yarn
7. Picks and Ends
8. Weight per square yard
9. Tensile strength and stretch
10. Abrasion and tensile strength
11. Fat removed and tensile strength
12. Shrinkage and strength
13. Bursting test
14. Weathering and strength
15. Bone dry and strength

Conclusions—for this group only.

Crimp.—The number of crimps per inch was greatest in the Rambouillet with Crossbred a close second. Karakul had the fewest crimps per inch.

Length of Fibre.—The average of the Karakul is 2.4 inches longer than the next highest which is the Crossbred. The shortest is the Rambouillet.

Diameter.—Karakul is the coarsest and Rambouillet the finest. Crossbred is very fine, but a few coarse fibres brought up the average.

Yarn Count.—The yarn count shows the yarns to be quite similar in weight, varying less than one per pound.

Twist.—The twists per inch varied less than one.

Thread Count.—The thread count was quite similar. Of the picks Rambouillet had the smallest number, 29½ with Shropshire the largest, 33. The ends varied less, i.e. 29 to 30½.

Weight per Square Yard.—The Crossbred gave 8:16 ounces per pound which was the lightest and the Rambouillet 9.61, the heaviest.

Tensile Strength and Stretch.—The Crossbred showed the greatest strength while the weight per square yard was the least. The yarn count was also the least in this fabric. The weakest is the Karakul, being 6.6 pounds less per inch. Here the weight per square yard is a trifle less than the Crossbred (.21 pound per yard less). The Karakul also showed the least stretch per inch.

Abrasion and Tensile Strength.—The tensile strength after abrasion also showed the Crossbred the strongest with the Karakul the weakest.

Fat Removed and Tensile Strength.—In this test the Rambouillet showed a slight advantage over the Crossbred, though after abrasion the Crossbred was again stronger than the Rambouillet. Southdown was the weakest in both instances.
Shrinkage.—The shrinkage on the length was quite near the same on all with a variation of only one per cent. Karakul shrunk the most, 4.1 per cent. The least shrinkage was shown in Rambouillet, Crossbred, Shropshire and Hampshire, 3.1 per cent each. The shrinkage in the width showed a greater variation. It varied from 0 in the Karakul to 6 per cent in Rambouillet.

Tensile Strength After Shrinkage.—Crossbred is the highest with Southdown the lowest (34 and 27 respectively). After abrasion Crossbred and Rambouillet rank the highest (32.3) with Southdown the lowest (23.3).

Strength of the Bone Dry Fabric.—The strength of the bone dry fabric was slightly greater than the fabric before it was dried though the stretch was less. The relative strength remained the same. Crossbred, Rambouillet and Hampshire were the highest with Southdown much the lowest.

Weathering Test.—The weathering test gave somewhat the same result. The increased strength here is probably due to shrinkage.

Entomology-Zoology

By H. C. Severin

The Plum Tree Borer (Adams)

The plum tree borer (Synanthedon pictipes G. & R.), its distribution, life history, economic importance and control.

The experimental work on this project was completed during the past year. Drawings illustrating the life cycle and seasonal cycle of this pest were made and photos were prepared showing the damage done to plum trees. A manuscript covering the results of the investigation is now being prepared by Professor Gilbertson and should be ready for publication before April 1934.

The Cryptacanthrinae Grasshopper (Adams)

*The grasshoppers of the subfamily Cryptacanthrinae of South Dakota, their economic importance, distribution, life histories and control.

Two thousand adult Cryptacanthrine grasshoppers were collected in South Dakota during the past year. These grasshoppers were mounted, labeled with locality, date and collector's labels and were then identified to the species or variety. The data thus acquired were recorded on the distribution of each species. Data concerning seasonal distribution of each species were also recorded. Considerable additional information was obtained concerning the natural food of some of the species. Records were taken regarding the relative abundance of each species during the year and regarding the economic importance of each species. The grasshoppers collected and classified were stored in Comstock cases, the specimens of each species being confined to a separate case or cases. Considerable study was made on color variabilities of each species and differences in size of body parts and proportions of these parts. This information gathered over a period of years should be extremely valuable in learning whether or not changes in climate and abundance of grasshoppers have any influence in modifying our grasshoppers, not only structurally but also physiologically (migrations).

A large number of specimens of Melanoplus differentialis and Melanoplus bivittatus were reared from the egg through the adult stage in order that we might be able to describe accurately each instar. This information
was not available from published matter, but we now have the same. Keys were prepared, by means of which it is now possible for us to separate any and all stages of these two species of grasshoppers.

We have also made detailed studies of the eggs of Melanoplus differentials, Melanoplus bivittatus, Melanoplus mexicanus mexicanus, and Melanoplus femur-rubrum femur-rubrum. Heretofore it was impossible for us to identify such eggs, but we are now able to do this. This information has all been recorded and is supplemented by drawings and photographs.

Additional information was obtained from experimental work relative to the effect of burial of grasshopper eggs. We have learned that burying the eggs to a depth of four inches or more will prevent the young hoppers from making their way through this soil to freedom, provided the soil is well compacted and not loose, and provided further that the soil is not too sandy.

We have also learned through our ecological studies that our four most important species of grasshoppers, namely, Melanoplus bivittatus, Melanoplus femur-rubrum femur-rubrum and Melanoplus mexicanus mexicanus, do not have identical seasonal life cycles nor identical food habits. This information is valuable especially from the control standpoint.

A study of the important insect enemies of grasshoppers and their eggs was continued during the past year, but we found that a study of blister beetles was so important and huge a problem that it was deemed best to make a separate project of it. Such a project was outlined, submitted and approved. Blister beetles of many species were extremely abundant in certain sections of South Dakota during the past year and since in the adult stage they feed upon many cultivated crops, the damage that was done by the beetles was enormous. On the other hand, in the grub state many of our blister beetles feed upon grasshopper eggs, and whenever this occurs, the insects perform a valuable service to mankind. We need an immense amount of information regarding the seasonal cycle of blister beetles, regarding their food habits in both the adult and grub stages, and regarding the control of the beetles whenever they are destructive, before the blister beetle problem can be considered solved.

Preliminary work was carried on in an attempt to find some ingredient that might be added to our poisoned bran baits to make them more attractive over a longer period of time. Various types of lubricating oil were used and some of these promise to become extremely valuable for our purpose.

Pollinating Agents of Sweet Clover (Adams)

A study of the pollinating agents of sweet clover in South Dakota with special emphasis upon seed production as influenced by the honey bee.

Because of the emergency that exists, namely, the necessity of gaining as much information regarding grasshoppers as possible, little time was devoted to this project. However, as much time as possible was devoted to identifying some of the collections of insects that were made some time ago from sweet clover flowers. From this type of information we shall ultimately be able to determine the species of insects that visit sweet clover in greatest abundance and also the role they play in seed production.
A project covering a study of the food eaten by the ring-necked pheasant in South Dakota was conducted by H. C. Severin during the past few years. This project was financed through the State Department of Game and Fish. A manuscript discussing the results of this investigation was completed recently and will be ready for the printers during the next two weeks. This manuscript covers 402 pages of typewritten matter and includes 23 cuts consisting mainly of graphs. This publication will be printed through funds furnished by the State Department of Game and Fish and will be the most thorough work on the food eaten by the ring-necked pheasant that has ever been printed.

Horticulture
By N. E. Hansen

Fruit Breeding (Adams)

This department does not conduct a commercial nursery, but propagates and distributes new varieties originated in this department or imported from similar climates of the Old World. The work of originating new fruits has been carried on the past 37 years by the writer. Many acres of seedling fruits have been grown since the work was started by the writer in 1895. The improvement in size and quality of each plant generation is greater year by year. Hybridization and selection are the main methods of improvement.

The work thus far is described in Bulletin No. 224, May 1927, and in the annual spring lists since that time. Other bulletins are: Experiments in Plant Heredity, Bulletin No. 237; Hardy Roses for South Dakota, Bulletin No. 240; The Shade, Windbreak and Timber Trees of South Dakota, Bulletin No. 246; Evergreens in South Dakota, Bulletin No. 254; The Ornamental Trees of South Dakota, Bulletin No. 260; Shrubs and Climbing Vines of South Dakota, Bulletin No. 263.

New Apples and Crabapples

The past season many acres of apple, crabapple and other orchard fruit seedlings were cleared at this station. Many choice varieties are left as a successful result of this work. Fourteen were selected and named for introduction. Scions or trees were sent out for the first time of all the fourteen varieties, including two apples, seven crabapples, four pears, and one sandcherry.

The experiments in taming the native American apple are yielding very encouraging results, indicating that the future winter apples—apples that will keep all winter in an ordinary cellar—will come from this line of work. The new apples with red flowers and red flesh will attract attention throughout the apple-growing world because they combine both the useful and the ornamental.

The following is a descriptive list of the 14 new introductions:

Lina Apple.—A seedling of Malinda and much like it in conical shape with blush, but with no knobs. Remarkable for its perfectly conical shape with no corrugations. The flesh is mild subacid and cooks up easily into light yellow sauce of good quality. It is much better than the Malinda itself which does not cook up easily. Name derived from Malinda. Season, winter.
Volga Apple.—A seedling of the Russian apple Anisim top worked on Virginia crab. Fruit 2½ inches diameter on much crowded trees, round, conical, brightest red all over with deeper red stripes and splashes. Basin very shallow, narrow, smooth, not corrugated as in Anisim. Flesh fine, juicy, pleasant subacid. Remarkable for the light red tint of the flesh outside the core outline. Season, late fall.

Travel Note: Anisim, named Beauty apple in its native land, I saw in splendid display at the great Agricultural Exposition in Kiev, southern Russia, in 1897. It was imported under various names, especially by Prof. J. L. Budd.

Bison Crabapple.—Large, red, of excellent quality. Pedigree: Johnathan apple x Silvia crab, making it one-half Jonathan apple, one-fourth Siberian crab, Pyrus baccata, and one-fourth Yellow Transparent apple. The tree is a heavy bearer. Under orchard conditions this may turn out to be almost an apple in size.

Caputa Crabapple.—Pedigree: Ivan crab x Kentucky Mammoth wild crab. A large, red, juicy, sweet, subacid crab, 1¼ inches in diameter. Tree productive. This is another of my International Series, combining the apples of North America, Europe and Siberia.

Wanablee Crabapple.—Pedigree: Elk River, Minnesota wild crab x Bismarck apple crossed with pollen of Wolf River apple. This makes the pedigree three-fourths tame apple and one-fourth native wild crab. The fruit oblate, 2½ inches in diameter, golden-yellow ground with brilliant red over most of the surface which makes it very attractive in appearance. In flavor the wild crab is dominant. It has possibilities for the plant-breeder and as an ornamental tree.

Waubay Crabapple.—Pedigree: Grimes Golden apple x Mercer Unguarded wild crab. The first fruits 1¼ inches in diameter, round, conical, brilliant red, evidently a remarkable all winter keeper. The Waubay evidently combines the rich, spicy, subacid sweet of the Grimes Golden with the long keeping capacity and hardiness of the seedling of the Mercer wild crab. Mercer Unguarded is an open-pollinated seedling of the Mercer crab from the Iowa Experiment Station. My recollection from student days at Ames is that the Mercer was planted near a Wolf River apple. This would explain the brilliant red color. The Waubay has fruited on trees greatly crowded in the seedling plantation. My experience indicates that when given abundant room as orchard trees, the fruit becomes much larger.

Zaba Crabapple.—Another crab with bright red flesh. Flowers red. Fruit red, exceeding 1½ inches in diameter. A complex hybrid of Duchess apple x Pyrus Malus Niedzwetzkyana with Siberian crab, Pyrus Baccata.

Zita Crabapple.—Pedigree: Pyrus Malus Niedzwetzkyana x Yellow Siberian crab. Flowers red, fruit red, regular, juicy, sweet, good quality, fully 1½ inches in diameter. Flesh red, especially inside core outline.

Zelma Crabapple.—Another of my series of crabapples with red flowers and red flesh. Fruit medium size, juicy, subacid, cooks into good red sauce. Both ornamental and useful. Pedigree: Pyrus Malus Niedzwetzkyana x Yellow Siberian crab.

Maga Apple.—The Maga crabapple first introduced in 1922 as a crab-apple, a seedling of McIntosh apple top—grafted on Virginia crabapple, must now be called an apple. Under orchard conditions in cultivated soil,
the fruit attains full commercial apple size and combines the high quality of the McIntosh apple with Siberian hardiness, the Virginia being part Siberian crab.

The past winter I studied over 600 native wild crab and other hybrids. My International Series appears of the most promise: the American wild apple contributes long winter-keeping; the Siberian apple, extreme winter hardiness; and the European cultivated apple, large size and high quality of fruit.

Izo Crab.—Izo crab introduced 1919, is found by John Robertson, Hot Springs, South Dakota, to be of special value as a stock for top-grafting standard apples. The first is a good winter keeper.

**Four New Hardy Pears**

Many thousands of pear seedlings are coming on at this station and in the State Orchard at Watertown. The object is to originate hardy pears immune or strongly resistant to fire blight, the bacterial disease which kills pear trees so frequently. Fire blight is a bacterial disease native of the North American continent. From my trip to North Manchuria in 1924 I brought back Pyrus Ussuriensis which is native of North Manchuria and eastern Siberia, from the farthest northwestern limit where it is found native, a few miles east of Harbin. This species is strongly resistant to fire blight.

Finland Pear.—A yellow pear, 2 inches in diameter, of excellent quality. Stem extra long. An open-pollinated seedling of the Yellow Early Finland pear planted next to a row of Russian sand pear. This Finnish pear was imported by the writer from Russia in 1904. Judging by its superior hardiness and blight-resistance, the Finland must be a hybrid of the Yellow Early Finland and the Russian sand pear.

Harbin Pear.—From the northwestern limit of Pyrus Ussuriensis, about 50 miles east of Harbin, Manchuria, where the temperature ranges from about -47°F. The bright red and yellow foliage in the fall makes this tree a fine ornamental. The value of this pear is its strong resistance to fire blight which kills the ordinary pear trees.

Krylov Pear.—A fine large early pear of good quality. Pedigree: Saponsky pear of eastern Siberia x Lincoln pear. Named in honor of a Russian poet.

Sadko Pear.—A fine large red pear of good quality. Pedigree: Russian sand pear x Vermont pear. Strong tree with good forks. Sadko is the hero of a Russian legend.

Sladky Pear.—A large pear, 2½ inches in diameter; yellow, sweet, good flavor. Sladky is the Russian word for “sweet.” Pedigree: Russian sand pear x Lincoln pear. Keeps well; season probably autumn.

**New Hybrid Sandcherries**

Mana Hybrid Sandcherry.—A hybrid of the native sandcherry of Dropmore, western Manitoba, with the Burbank, a Japanese plum. Fruit round, 1 inch in diameter. The green-yellow flesh of pleasant quality and cooks into rich, red, good flavored sauce. Pit of medium size with rounded edges and no sharp points. The round shape of this fruit will sell it as a cherry. The name is condensed from Manitoba. This new cherry for the prairies should be of interest at the North.
Sanoba Hybrid Sandcherry.—Introduced 1929. Pedigree: Sapa x Dropmore, Manitoba sandcherry. The name is made up from the two words, Sapa and Manitoba. The Sapa is my hybrid of the South Dakota Sandcherry with a Japanese plum and is famous for its black-red flesh of choice quality. At Brookings the Sanoba is a good plant, productive, of upright habit; fruit thirteen-sixteenths inch in diameter; flesh red, good quality; pit round and small.

Rose Breeding (Hatch)
Many promising seedlings have been selected from the thousands of seedlings originating from the rose breeding experiments and are now in propagation.

Thornless Rose Stocks (Purnell)
Progress in Thornless Roses: In clearing twenty acres of rose seedlings in 1932 in the State Rose Garden at Sioux Falls and at State college, a few 100 per cent thornless rose plants were selected for further work. Both leaves and wood are smooth. Some 5000 plants with thornless wood have already been selected for the hardy thornless stocks. The main problem so far is to find seedlings with the midrib and stem of leaves free from the bristles which are so annoying.

Plant Explorations
The work of collecting native plant material was continued in many parts of South Dakota, also eastern Manitoba and western Ontario. New results are best obtained by collecting new materials.

Pharmacy
By F. J. LeBlanc

A Study of the Properties of Chenopodium

A study of the properties of the oil of chenopodium obtained by cross-fertilization of chenopodium ambrosoides with a wild variety obtained from Kansas, as well as the study of the anthelmentic value of the oil obtained from this cross in the treatment of ascaris. (Purnell.)

Another variety of chenopodium was added to those already being grown in 1931. This was a wild variety found growing in Illinois. Chenopodium sown directly in the ground germinated well. A good stand was obtained, as well as a considerable amount of seed collected.

For the past three years growing conditions in South Dakota have not been normal due to a lack of moisture. However, the chenopodium plants seem to stand the drought well and when sufficient moisture is available they develop into large hardy plants. Even when moisture is lacking good plants are obtained.

Distillation was carried on in the usual manner. The total weight of the plants distilled was 4433 pounds and the yield of oil was 2025 cc.

Chenopodium plants cut early yield more oil than plants cut the latter part of September. The oil, however, is lower in the active constituent when cut early. The plants remain green after several frosts, but on distillation after this has happened the amount of oil is found to be less.

The pigs used in this experiment were divided into six lots of eight head each. They consisted mainly of Duroc Jerseys with a few Chester
Whites and Poland Chinas. They were farrowed between April 1 and April 20. The average initial weight of pigs when placed on experiment were as follows: Lot 1, 32.3 pounds; Lot 2, 33.9 pounds; Lot 3, 33.3 pounds; Lot 4, 31.8 pounds; Lot 5, 33.9 pounds and Lot 6, 33.8 pounds. The average weight of the pigs on conclusion of the experiment was 225 pounds.

One of the six lots of pigs was wormed considerably earlier than any of the other lots. This lot made the most economical gains.

The pigs in Lot 2 were not wormed with oil of chenopodium, but had chenopodium plants as forage. Examination of feces showed fewer worm eggs at all times than any of the other lots and postmortem examination actually showed fewer worms. The pigs ate the green chenopodium plants readily. The results of this first years work proved very encouraging and more work will be done along these lines.

Preliminary work has been started on the worming of sheep with chenopodium.

Poultry

By W. C. Tully

The Effect of "Alkalied" Grain on Growing Chicks and Poultry (Purnell)

Cooperative with Department of Chemistry

This is a continuation of last year’s work. While only eggs from the pen receiving 65 per cent of “alkalied” grain showed influence of being “alkalied,” as demonstrated by decidedly low hatchability as well as by deformities of dead embryos described last year, after several hatchability trials it was decided to discontinue Pen III (25 per cent “alkalied” corn), and pen IV (25 per cent “Alkalied” barley) on February 22, 1932. By recombining birds 2 pens were continued, Pen I being fed 65 per cent normal grain, and Pen II 65 per cent “alkalied” grain made up of 25 per cent each of corn and barley and 15 per cent wheat. Egg production records on a hen day basis were kept for one year, pen I producing 172 eggs per bird and pen II 147. The use of 65 per cent “alkalied” grain in an otherwise complete ration decreased egg production 25 eggs per hen per year when compared with the check lot receiving a normal complete ration. Several additional hatchability tests were run on eggs from both of the above lots with results similar to those previously found, that 65 per cent “alkalied” grain reduced hatchability to practically nothing, and of chicks dying in the shell from 11 to 21 days all were somewhat deformed and the majority showed extreme variations in formation from the normal appearing embryo.

Additional work on this project for the year was a study to determine the differences in feeding values of eggs from each of the above lots. However, a nutritional trouble similar to that first described in chicks by Ringrose, Norris, and Heuser was encountered.

All eggs used in these three feeding trials with chicks, each trial composed of four lots of 25 chicks each, were dried in an incubator at a temperature never higher than 115°F. Fifteen per cent dried egg and five per cent dried buttermilk were the chief animal protein supplements used. The nutritional disease appeared when chicks were approximately three weeks old and affected the mouth, principally at the junction of the upper and lower mandibles, and the bottoms of the feet.
Three per cent of Yeast-Foam Tablet Powdered (dehydrated yeast cells not autoclaved) when used with the above supplements in an all-mash ration increased growth but had no effect in controlling the skin lesions. Five per cent of similar yeast, or five per cent yeast plus three per cent meat and bone scrap did not control this trouble. Whole egg is rated a rich source of vitamin G, while yeast is a most potent source, yet neither prevented the appearance of this pellagra-like syndrome.

Another experiment was completed during the year and was to determine the permanence of effect, particularly on hatchability, of feeding 65 per cent "alkalied" grain to laying hens. The feed in pens I and II, described above, was changed so that pen I received the "alkalied" grain and Pen II the normal ration. Setting X, including all eggs laid in pen I for the first three days after the change of feed, gave a hatchability of 75 per cent of fertile eggs, and there were no deformed chicks, showing that there was little effect from the feed up to this time. Eggs of the next three days, however, hatched only 28 per cent and some "wirey" feathered chicks were found, showing that after only 6 days the "alkali" effects were very evident. None of the eggs, laid from 7 to 9 days after changing feed, hatched, and deformities were present which with later settings increased in severity until the eggs of the 13th to 15th days showed malformations as intense as any ever found. In pen II, which had been on "alkalied" feed their entire lives until the change, only 15 days were required on good feed to increase hatchability of fertile eggs from 0 to 57 per cent with absence of all signs of deformed chicks. This work indicates rather definitely that the serious effects of "alkalied" grain on poultry are not permanent.

Feeding Values of Wheat and Wheat By-products (Purnell)

This year's work is the third experiment on this same project. As a result of the two previous experiments, the first of only four months duration, but the second of nine months, as well as of the present experiment which has been run for 6 months and will be continued at least 2 more, we are justified in suggesting that with the particular ration used, which is given below, equally satisfactory results can be secured where 30 per cent ground durum wheat in the mash part of the ration replaces the more usually recommended wheat by-products, in this case 15 per cent each of wheat bran and wheat flour middlings. The wheat used in previous experiments was similar to that used in the present experiment but was incorrectly reported as hard wheat which is not commonly used in this section for poultry feeding unless durum is unavailable.

Reference to Table I will show in some detail the results for six months of this year's experiment which substantiate work of the previous two years. Pen I received 30 per cent of finely ground durum wheat in the mash; pen II 15 per cent each of bran and middlings; pen IV 15 per cent each of ground wheat and ground bran; pen V 15 per cent of ground wheat and wheat middlings. The rest of the mash for all pens was as follows:

<table>
<thead>
<tr>
<th>per cent</th>
<th>ground yellow corn</th>
<th>pulverized oats</th>
<th>meat and bone scrap</th>
<th>dried buttermilk</th>
<th>alfalfa meal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>33</td>
<td>10</td>
<td>14</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>
The grain ration, in this year's experiment fed like the mash, ad libitum in hoppers, was composed of the following:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>steamed bonemeal</td>
<td>1</td>
</tr>
<tr>
<td>common salt</td>
<td>1</td>
</tr>
<tr>
<td>cod liver oil stearine</td>
<td>1</td>
</tr>
</tbody>
</table>

The use of ground wheat or mill-products would depend therefore on local price rather than results. In last year's report it was stated that ordinarily the price of wheat by-products is considerably higher than the wheat from which they are made. As this is true in many parts of South Dakota it applies however, only to retail prices and to poultry raisers a considerable distance from mills. This will be discussed in more detail when results of this project are published.

Table I

<table>
<thead>
<tr>
<th>Pen</th>
<th>Total production per bird, hen day basis, Jan. 1, 1933 to June 30, 1933</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pen I</td>
<td>104.9</td>
</tr>
<tr>
<td>Pen II</td>
<td>102.9</td>
</tr>
<tr>
<td>Pen IV</td>
<td>103.8</td>
</tr>
<tr>
<td>Pen V</td>
<td>107.1</td>
</tr>
</tbody>
</table>

Comparative Metabolism of Several Calcareous Materials

In Poultry Feeding

Cooperative with the Agricultural Experiment Station
Chemistry Department (Hatch)

This experiment which was run from November 18, 1932 to June 8, 1933 completes 6 years of work to determine accurately differences in results, as measured by production, egg size, egg shell breaking strength, and body maintenance and mortalities in birds, among several calcareous materials, more commonly spoken of as line supplements, for laying hens. The four lime supplements used in the present year's experiment were oyster shell, Black Hills limestone, "Shellmaker" limestone, and commercial calcite. Previous year's work showed that a dolomitic type of limestone was not practical as almost twice as much of this material was used as any other lime supplements tested. Results substantiate those found in previous years and will be published in more detail in a bulletin to be published this year.

Study of Rammed Earth Construction in Poultry Houses

Cooperative with Department of Agricultural Engineering
(Station Local)

This experiment, started in the fall of 1932, has been in progress less than one year and the results for the first winter's work are therefore only suggestive. The rammed earth house, constructed similarly to the South Dakota type laying house, except that the four walls were of rammed earth construction, proved very satisfactory for laying hens.
Detailed bi-daily temperatures were kept inside this house as well as inside another straw loft type poultry house for comparison, in addition to outside temperatures. The rammed earth house remained warmer than the wooden house after severe drops in temperature, but also was slower to warm up with moderations in temperature. Feed and egg production records were kept for the first winter's work, and temperature records are being continued for another year.

**Rural Sociology**
By W. F. Kumlien

**The Growth and Decline of South Dakota Trade Centers, 1901-1933** (Purnell)

The findings of the study show the effect of rainfall, population density, trade center density, the building of railways and auto highways, the extension of rural postal routes, and the diffusion of the automobile among farm people upon the growth and decline, the appearance and disappearance of South Dakota trade during the period covered. The study shows that there have been many casualties among the small trade centers but that other new centers have sprung up to fill their places. Looking at the movement as a whole, there has been a net loss in the number of trade centers.

The study also shows a tendency for larger trade centers to grow and for small trade centers to decline, both in function and in size, since the adoption of the automobile as the farmer's mode of travel.

**Social Change in Brookings County** (Purnell)

A series of approximately fifty selected social trends are first set forth, covering the period from 1880 to 1930, or approximately the entire life history of the county. These fifty selected trends deal with what are thought to be the most important changes that have taken place in the economic, familial, governmental, educational, religious, health and recreational aspects of the lives of Brookings county peoples.

The second part of the study is an analysis of the causes lying back of these social changes. The external factors of physical environment, race and nationality, heredity, physical type and economic forces, together with the psychological and cultural factors are all considered in the order named. An attempt is made to evaluate their respective influences on social change. The manuscript dealing with the findings and conclusions of this study is now in the process of final preparation.
Hemorrhagic Septicemia Project No. 1 (Adams)

During the fiscal year that closed June 30, 1933 a detailed study of hemorrhagic septicemia organisms was made with especial reference to their ability to be used for the production of an immunity in laboratory animals. The results obtained were checked with stock hemorrhagic septicemia vaccines secured from reputable dealers in biologic products. The results of our work during the year just closed indicate that not all strains of hemorrhagic septicemia organisms may be used for the purpose of vaccine production if immunity is to be secured in the vaccinated animals.

Purnell Fund

Project No. 1  Oil of Chenopodium—Pharmacy
Project No. 7  Nutrition—Home Economics
Project No. 4  Wheat Feeding—Poultry
Project No. 5  Alkalied Grain for Chicks—Poultry
Project No. 1  Grazing Sweet Clover, etc.—Dairy

The Veterinary Department of State college is cooperating with various other State college departments in the above research projects. Since the Veterinary department is but a cooperator, no definite report can be made; neither can conclusions be offered.

Various trips to the Morrell Packing Company were made during the year to examine hogs sent for slaughter that were in an “Oil of Chenopodium Experiment.” The inspection was made by Doctor Taylor for the purpose of determining whether or not the pigs slaughtered suffered from common round worm infestation.

A large number of sections of the teeth of guinea pigs were made by Mr. Spawn under the direction of Doctor Taylor in the Vitamin experiment being conducted by the Home Economics department. The sections were studied microscopically and many of them photographed.

The Poultry department submitted fowls from time to time on their Purnell Projects. These fowls were examined carefully in order to determine the cause of their death and reports were sent to the Head of the Poultry department.

No assistance was given the Department having the grazing of sweet clover project in charge.
## Financial Report

By R. A. Larson

### Receipts

<table>
<thead>
<tr>
<th>Hatch</th>
<th>Adams</th>
<th>Purnell</th>
</tr>
</thead>
<tbody>
<tr>
<td>$15,000.00</td>
<td>$15,000.00</td>
<td>$60,000.00</td>
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</tbody>
</table>

### Disbursements

<table>
<thead>
<tr>
<th>Item</th>
<th>Hatch</th>
<th>Adams</th>
<th>Purnell</th>
</tr>
</thead>
<tbody>
<tr>
<td>By Salaries</td>
<td>$9,332.99</td>
<td>$8,921.81</td>
<td>$34,548.47</td>
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<tr>
<td>Labor</td>
<td>1,682.93</td>
<td>2,758.88</td>
<td>9,746.22</td>
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<tr>
<td>Stationery and Office Supplies</td>
<td>463.70</td>
<td>95.04</td>
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<tr>
<td>Feeding Stuffs</td>
<td>735.18</td>
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<tr>
<td>Scientific Supplies</td>
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<td>1,699.27</td>
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<td>Sundry Supplies</td>
<td>213.76</td>
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<td>901.32</td>
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<tr>
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<td>10.41</td>
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<td>772.89</td>
<td>1,742.85</td>
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<td>Heat, Light and Water</td>
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<td>54.16</td>
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<td>31.32</td>
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<td>3,390.16</td>
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<td>Livestock</td>
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<td>--</td>
<td>592.40</td>
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<td>950.26</td>
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<tr>
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<tr>
<td>Contingent</td>
<td>--</td>
<td>--</td>
<td>.50</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$15,000.00</strong></td>
<td><strong>$15,000.00</strong></td>
<td><strong>$60,000.00</strong></td>
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### Experiment Sub Station

- **Balance on hand July 1, 1932**: $5,524.69
- **Receipts from Land Rentals**: 1,842.89
- **Receipts from Sales of Produce, Cottonwood Sub Station**: 543.95
- **Receipts from Sales of Produce, Eureka Sub Station**: 74.40
- **Receipts from Sales of Produce, Highmore Sub Station**: 128.58
- **Receipts from Sales of Produce, Vivian Sub Station**: 506.30
- **Receipts from Sales of Produce, Newell Sub Station**: 3,584.96
- **Total**: $12,205.77

### Expended

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<th>Item</th>
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</thead>
<tbody>
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<td>Fertilizers</td>
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<tr>
<td>Communication</td>
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<tr>
<td>Description</td>
<td>Amount</td>
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**Sales Fund (Brookings Station)**

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**Expended**

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>Salaries</td>
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<tr>
<td>Labor</td>
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<tr>
<td><strong>Total</strong></td>
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**Horticultural and Livestock Experiment Fund**

<table>
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<tr>
<th>Description</th>
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<tbody>
<tr>
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**Expended**

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<thead>
<tr>
<th>Description</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Salaries</td>
<td>$6,773.15</td>
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<tr>
<td>Labor</td>
<td>3,462.04</td>
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<td>Stationery and Office Supplies</td>
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<td>Scientific Supplies</td>
<td>129.19</td>
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ANNUAL REPORT

Feeding Stuffs .......................... 1,277.80
Sundry Supplies ......................... 255.52
Communication Services ................. 26.13
Traveling Expenses ..................... 1,197.17
Transportation of things ............... 185.22
Livestock ................................ 907.28
Tools and Machinery ..................... 508.52
Building and Land ....................... 85.08
Furniture and Fixtures ................. 43.00
Scientific Equipment ................... 101.98
Contingent ................................ 2.38

Total ................................... $15,000.00

Potato Experiment Fund

Appropriation ................................ $841.10

Expended
Salaries .................................. $649.32
Sundry Supplies ......................... 10.59
Labor ..................................... 25.50
Scientific Supplies ..................... 4.95
Communication ........................... 6.70
Transportation of things ............... 8.95
Tools and Machinery .................... 113.18
Buildings and Land ..................... 21.91

Total ................................... $841.10

Popular Bulletin Fund

Appropriation ................................ $1,261.65

Expended
Publications ............................... $1,261.65

Sub Station Funds

<table>
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<tr>
<th></th>
<th>Highmore</th>
<th>Eureka</th>
<th>Cottonwood</th>
<th>Vivian</th>
</tr>
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<tbody>
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<td>Building and Land</td>
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</table>

Total ................................... $2,716.75 $2,716.75 $2,716.75 $2,716.75